Machines of the Invisible: Changes in Film Technology in the Age of Video

Charles Eidsvik

continuing down that road. It's a long way from growing up in Hollywood and what we thought then or what we perceived.

My choice as a working artist is not to play to the marketplace. It's not because I don't know how. I've chosen another path. As hard as my life is, and it is hard without Johnny, I wake up every morning and I can't wait to get to work.

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Until the early 1970s, critical discussion of film technology and practice was a preserve monopolized by film-makers and by theorists such as André Bazin and Jean Mitry who were in close contact with film-making communities and often served as intellectual spokesmen for views commonly held by film-makers. The film-making community, in trade journals such as *The American Cinematographer* and *J.S.M.P. T.E.,* traded secrets, discussed craft, and cele-brated its lore, myths, and mystique. Theorists and historians such as Bazin and Mitry—Mitry was himself a film-maker—built film-makers' perspectives into their views of how new technology catalyzes change in film history. This view, which permeates Mitry's *Esthétique et psychologie du cinéma* and can also be found in essays such as "The Myth of Total Cinema" by Bazin, posits an "Idealist" and "technologically determinist" view of history, with film technol-

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ogy allowing film-makers ever greater potential for recreating reality.[1] Though technological determinism is an understandable belief among film-makers, whose jobs depend on machines, and for whom belief in technological determinism is anxiety-lessening, the position is hardly intellectually respectable.[2] Once Althusserian Marxism began to explore relationships between ideology and technology, an attack on "Idealist" and technologically determinist positions was inevitable. The attack, led by Jean-Louis Comolli, J.-L. Baudry, and Stephen Heath, attempted to critique technology within a "materialist" approach to cinema. Soon joined by feminist film critics such as Teresa de Lauretis, the analysis of technology and ideology has become a mainstream approach to technology at least within academe.

Though the academics (and Comolli himself) are prone to gaffes when discussing specific technological practice,[3] one cannot quarrel with their intentions or intelligence. Nevertheless, insofar as the job of historians is to account for change, their approach has little future, not because their methods—the search, for example for codes to which technology speaks—are weak, but because they have chosen to write and work from the "position of the spectator," from what can be seen and heard on movie screens, rather than on "tainted" film-maker-generated technical histories.[4] This would be fine except for a simple problem. Not only do most movies, in George Lellis's terms, "seek to hide the methods by which they produce their illusions,"[5] new production practices often are deliberately made invisible and inaudible to film spectators. Information on new technical practices is only briefly hinted at in trade journals but primarily is passed on through actual film-making.

If the last decade is any indication of how change occurs in cinema, a lot goes on below the realm of the easily perceivable. The central fact of recent cinema is the film industry's attempt to survive in the face of overwhelming competition from video. Film can compete with video only as a producing and large-screen exhibition medium. As a producing medium it can compete only on the basis of "quality," with quality defined as something film is not trying to achieve but already *has*. Technological innovation has largely served the purpose of making that quality either "better" or easier to achieve, but not different basically from the quality that already exists. New technology thus has expanded what can be filmed but not (deliberately at any rate) how we are meant to see films. Except in the area of special effects, an area in which mainstream film-makers have been able to use the old Hollywood ploy of turning big budgets and technical prowess into a publicity stunt, conceptually conservative technological innovation has been the norm. In understanding this innovation, perhaps the only relevant theorist would be Michel Foucault, whose approach to power struggles is relevant to just about any study of technical change.[6]

But the power struggle has been basically defensive. In the last decade, the majority of technical developments in the film industry have been aimed at facilitating extant production practices rather than at changing the "look" or sound of commercial films. Just about every new product has been advertised as something that makes film-making cheaper and easier, usually by allowing smaller crews or less schlepping of equipment on location. For each problem to be solved—light levels needed for shooting, the problem of equipment weight, problems of camera mobility, or the difficulty of getting good sound on location—different companies have offered competing solutions. For low-light filming, for example, Kodak, Fuji, and Agfa have offered faster filmstocks; Zeiss, Angenieux, Cooke, and Panavision have offered faster, sharper lenses; and various makers of lighting equipment have developed lights and light-control equipment that require little electricity and are highly portable. Alone, each new technology has had little effect. But in aggregate, the dozens of new technical possibilities made available have radically altered the construction and implied worlds of commercial narrative films. In terms of David Bordwell's "style-syuzhet-fabula" triad,[7] the technical developments have had surprisingly little effect on style, but a discernible effect on syuzhet (plot) construction. This has occurred because the new technologies allow more on-location film-making control, and thus freer use of the kinds of settings that can easily be shown, rather than left as syuzhet gaps, in fiction films. I will return to this issue later, after a review of the major recent changes in film technology.

How film-makers get images has been directly affected by changes in filmstock technology,

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lenses, and cameras meant for location use. But the primary change in visuals has been indirectly created through Automated Dialogue Replacement (ADR) in postproduction. ADR masks its own existence so well that it is not audibly detectable to a film viewer. It has been radically liberating as a catalyst for other shifts in technical practice.[8]

The most important of the visual-technology shifts has been in an expected area, filmstock technology.[9] Until the mid-1970s Eastman's 5254/7254 negative was standard for narratives; when the new 5247/7247 stock came in, films changed visually and film-making got easier: the stock had such fine grain and wide exposure latitude (7 to 10 stops of light acceptance) that it became a new standard, one still more or less prevalent. Since then Eastman, in addition to unpublicized refinements of 5247, has produced three generations of high-speed stock, a fine-grained and contrastier replacement for 7247 in 16mm (7291), a daylight-balanced version of 5247 for use with the new high-efficiency "metal-halide" arc lamps known as "HMIs," and a stock designed purely for matte work in special effects film-making. Though the newest high-speed stocks have six-layer emulsions[10] and flattened-molecule technology (which combine to allow high-speed film-making without visible grain), each stock intercuts smoothly with the basic "47." The new high-speed stocks are rated at ASA 320 (compared to 47's ASA 100) and can be rated faster, even without extended lab development ("pushing"). For example, *Full Metal Jacket* was shot with the film rated at ASA 800.[11] To the viewer, almost nothing has changed in a decade. But because of the increase in film speed without increase in grain, now very low-light scenes can be filmed easily; because of compatible tone and grain-structure architecture, interiors and even night exteriors are similar in "look." Eastman, Fuji, and Agfa stocks can coexist as stylistic variants even within a single film without a viewer noticing.[12] The effect has been on the *kinds* of shots that can be incorporated into narratives smoothly. Night-for-night filming is now relatively easy, provided the new "superspeed" lenses are used.

Low-light filming problems also were "solved" by lens and lighting manufacturers unobtrusively. Quicker and sharper zoom and prime lenses enhance the possibilities of fast stock without introducing their own "look."

Where it used to take 100 footcandles of light to get sharp images a decade ago (because older lenses were only really sharp stopped down) now 25 footcandles or even 10 is common. (In Eastman's demonstration film for film-to-video transfer techniques, one romantic candle-lit scene is lit with only one ordinary candle; it looks fine.) Not only is frying no longer an occupational hazard for actors; syuzhet construction now has very few light limitations. And because lighting problems in narrative film-making are in good part problems in schlepping lights and light-control equipment, and in getting juice to the lights, more efficient units such as HMIs have become popular. (An HMI is around five times as efficient as a tungsten lamp, twice as efficient as a carbon arc, and is daylight-temperature.) Quicker lighting set-ups with less generated heat and smaller electricity requirements expand location possibilities.

The additional location flexibility made possible by new visual tools made location work cheaper and easier; it also made story construction a bit different in potential. More low-light locations could be used, and they could be used in new ways. The city night locations of a *Desperately Seeking Susan* or *After Hours* were predicated on the new tools and stocks. Certainly night exteriors are not new; the ease with which they can be put into films *is*.

Complementing and accelerating the changes brought by stocks, lenses, and lights are post-production sound developments. ADR, based on "insert" electronic technology (which "ramps" the onset of the bias tone so that sounds can be inserted in a track without pops or other recording artifacts) makes it possible to clean up location sound tracks or unobtrusively to replace location sound entirely in post-production. Now so ubiquitous that almost every feature film lists ADR credits, the art of sound replacement and remixing is an unsung but central contemporary film- and video-making craft. But except for the remarkable intelligibility of dialogue made possible by ADR and new versions of sound tools such as radio microphones, the main effect of new sound technology has been to free up crews on location. No longer is a take spoiled by bad sound; no longer need a boom shadow be in the way; no longer must the sound of a moving camera be so care-

fully masked. But the use or non-use of ADR in a scene is undetectable.

Curiously, a by-product of ADR has been in characterization and acting styles. Actors such as Robert DeNiro now often just mumble their lines on-location, and depend on ADR sessions to get the right intonation and subtextual subtlety into the final film.[13] Before ADR Europeans (such as Bergman) frequently "matched" dialogue either because of bad recording conditions or to re-do performance nuances;[14] with ADR this technique has become common, even everyday. Actors who do not have to project their voices can present different aspects of character than those who must be heard clearly by location microphones. Potentially this could cause large shifts in story and character construction. But the trick to the technique working is for the actor and film-maker not to get caught by viewers. Acting styles have changed since ADR. But only those within the industry know how or why.

The cameras used to shoot also have changed, and similarly, it is impossible to tell what camera has been used in any recent normal-format film. Which of the four generations of Arri 35BL or two generations of Moviecam or myriad generations of Panavision/Panaflex cameras a film was shot with is in no way visible. (Similarly it is impossible to tell what camera recent 16mm films were shot on.) Each generation in each manufacturer's line has become quieter, more reliable, more adaptable to video viewfinders, and more versatile, particularly for location filming, but no recent camera has advertised its existence to the viewer.

The most obtrusive technical change outside of the area of special effects in the last decade has been in camera movement. The Steadicam, Louma-type crane, Camrail, and jibbed dolly systems that have allowed us our current period-style of perpetually moving cameras are all consequences of fitting video viewfinders to film cameras, thus making them remote-controllable. The earliest uses of these tools were obtrusive: in *Bound for Glory* when the camera glided through a crowd smoothly and in ways not conceivable with a boom or dolly, the effect was startling; so was the camera smoothness in *An Unmarried Woman* when the camera went up flights of stairs with the actors; so were the hallway and maze and stairs moving-camera scenes in *The Shining*. But the Steadicam has

become just part of current film technique, and the different devices for moving a camera by remote control are used in films almost interchangeably, usually without calling attention to themselves. The basic principle behind all the devices is that a camera can be moved more freely if its 50-lb. weight can be separated from the weight of the operator and focus-puller. Remote control and video tapes solve the problem: in the Steadicam by physically isolating the camera from the "handholding" operator; in the Louma and jib-based rigs by putting the controls at a console and locating the camera at the end of some sort of boom, with mechanical, hydraulic, or electronic servocontrol systems that allow manipulation of all camera controls.

Are developments in moving-camera technology revolutionary? They seemed so in the 1970s; now the situation is less clear. As the mobile camera became more common, the stylization apparent in a film such as *The Shining* has blended into a repertory of mobile-camera/stationary-camera paradigms. But these paradigms are not so much the consequence of technologically created opportunity as of an economics- and video-driven loss of other esthetic options. A decade ago, a film-maker could use the edges of the frame as part of compositional graphics—to lead the eye, to counterbalance other visual elements. But now cable and video distribution is the financial heart of the media storytelling business, so film-makers have to keep essential information away from the edges of the screen, and have to forget about using the graphic potentials of 2.3:1, 1.85:1 or 1.65:1 frame formats. All films must be composed for what the Europeans call "amphibious" life, for viewability on both on theater and on television screens. Without control of the shape or edge of frames, visual control must be done kinetically—especially because TV screens do not carry enough visual information for long-held static shots to retain viewer attention. Glance Esthetics, our contemporary period-style, has almost completely replaced Gaze Esthetics, in which film-makers left time for the viewer to contemplate the *mise-en-scène*. Glance Esthetics (perhaps seen in purest form on music videos) requires the moving camera. But it seems far less than obvious how one might analyze stylistic changes forced by economic changes that themselves reflected new technologies and broader-scale power struggles

within society. And the longer the new camera-moving technologies are with us, the less radical they seem—the more they seem mere successors to the dolly-shot esthetics championed by Max Ophuls and a whole batch of New Wave film-makers.

The sum of the technical shifts in the last decade has been to increase the possibilities of location film-making and to free film-makers from some logistical and financial production hassles. Though it would take statistical analysis to prove or disprove my impression that location exterior (and especially low-light) scenes are much more common now than they were a decade ago, and that they now more frequently form parts of the syuzhet rather than syuzhet gaps, the major drawback to such scenes (their cost) has been lessened. The film industry's ability "to turn the world into a story" (to use Mitry's famous phrase) has been increased in that more kinds of "natural" scenes can now be appropriated for fiction. But there is very little that is esthetically revolutionary in the new technologies, and nothing that would upset the basic film-making power structure. Changes have been conservative, a defense against inroads and threats brought by very rapidly evolving video technologies. Pressure from the outside rather than forces within the film industry has given us the new toys we work with on location. Each of these toys also plays to the extant power structure within the film-making community.

To grasp how new technology functions it is perhaps helpful to outline the economic and professional interests each technical shift favors. Low-budget film-makers, pushed out of the "industrial" market by video, mostly switched to video, bankrupting a lot of small 16mm equipment manufacturers and labs in the process. But at the higher budget levels, the mystique of film quality was promoted heavily by everyone from Eastman on down. Those with the most to lose by competition with video pushed the new technologies hardest. Craftspeople with a life invested in film technique were eager to try any new film tool that would make them more competitive. Rental houses could make money renting out new "top of the line" tools that changed quickly enough to keep film-makers from wanting to buy them, but still were rentable becuase they "worked like" older tools. Equipment manufacturers exploited film-

makers' desire to survive and the willingness of rental houses to buy their stuff as a nudge to bring out "ever-better" tools. Accommodation was made to eventual video use by promoting the use of film as an originating medium and accepting the reality of Rank-Centel or Bosch video transfer. Driven by the nightmare of hearing the phrase "we could just as well have done it on tape," the film community made its internal power accommodations and promoted its mystique of quality in order to survive in the higher-budget ends of the industry. In a weird sense, the threat from video was approached with a triage mentality. What was irrevocably lost was simply accepted—films would be transferred to and shown on video. What was seen as "working" all right without change, that is, film's basic rhetoric and "tradition of quality," was deliberately *not* undermined by technical shifts but instead was reinforced. What was changed was production practices and technology. The changes made here were meant to *expand* the domain of fictionalized establishment practices into areas in which video could not compete well, such as location film-making. Video has (at least at present) real problems in dealing with on-location light contrasts. Film's light acceptance range makes it unbeatable on-location. A battery of technical changes were gradually instituted so that film's on-location advantages could be maximized. The last decade has been a power struggle between factions in the entertainment industry. Technology has simply been a tool for gaining or retaining financial power.

What can be said about the relationships between change in cinema and technical change on the basis of recent film history? Nothing very global. There have been some changes in what we see and hear and how actors act. But each change, as it came, was so subtle, so well masked, that no major change ever was "felt" by audiences. The film industry's defensive maneuvers of the 1970s and 1980s are far different from the flaunting of color, 3-D, and widescreen in the 1950s (and judging by industry finances, far more successful). But the changes that have occurred are still not fully played out, so to argue either the parallels or differences between the last decade and preceding ones would be to deny the complexity (and complex approaches to the craft) of film as a technological medium and art form. In film, as Ingmar

Bergman put it, "God is details." So large theoretical claims must be put on hold, or at least balanced with one another in recognition of the different perspectives from which cinema can be seen.

The basic problem in theorizing about technical change in cinema is that accurate histories of the production community and its perspectives, as well as of the technological options that face film-makers, must precede the attempt to theorize. And theory itself must limit itself to a little bit of history at a time. It is not that we do not need theory that can help us understand the relationships between larger social and cultural developments, ideology, technical practice, and the history of cinema. Rather it is that whatever we do in our attempts to theorize, we need to welcome all the available sources of information, from all available perspectives, tainted or not, and try to put them in balance. Anything less than that approach lessens us as students of cinema by denying the complexity of the art we study.

<div align="center">NOTES</div>

1. See André Bazin, "The Myth of Total Cinema," *What is Cinema?* Vol One. Trans. Hugh Gray. Berkeley: University of California Press, 1967, 17–22. Mitry's position, often lumped with Bazin's, puts the "advance" technology allows differently: new technology gives film-makers ever-greater means to manipulate images of reality. Mitry defended his position in virtually monthly columns in the French journal *Cinématographe* until at least 1984. Though attacks on his position often are printed in English, his defenses and counterattacks were far more interesting than the attacks. Often Mitry argued that his semiotics-trained attackers knew very little about cinema.

2. For a general put-down of technological determinism see Brian Winston, *Misunderstanding Media.* Cambridge: Harvard University Press, 1986. More specific attacks on the perspective in film history are undertaken by Barry Salt in *Film Style and Technology: History and Analysis.* London: Starword, 1983.

3. For example, Stephen Heath, in *Questions of Cinema,* attempts an attack on Liz-Anne Bawden's comment, in the *Oxford Companion,* "It is technical advances which underlie stylistic innovations like handheld techniques . . ." Heath writes: "Arriflex cameras were available in Hollywood in the late 1940s but there was no particular turn to handheld sequences in response to the technical advance (nor in France at the same period in response to the Eclair Cameflex)." (230) Heath's example is silly. The old Arri and CM3 Cameflex were good handheld cameras but neither was pin-registered or self-silenced. Until recently, American professional film-makers rarely regarded a non-pin-registered camera as reliable enough for feature use. And without a blimp the Arri and Eclair could not be used for dialogue shooting; the Eclair, with its ratchet drive, was especially noisy. Blimps added between 85 and 110 lbs. to either camera's weight and made the cameras useless for hand-holding. The Arri and Cameflex caught on slowly as "wild" cameras and for European low-budget productions where dubbing-in of dialogue was the norm. But they were technically unsuited for the mainstream industry. Bawden, in fact, is correct if one adds "self-silenced" to her "hand-held" comment. The 16mm Eclair NRP and ACL and the Auricon conversions of the early 1960s did allow the *cinéma vérité* movement to exist. The interplay between tools and tool-users is far more complicated than many academics such as Heath would like to admit. Even Comolli—who as a film-maker should know better—in his essay, "Machines of the Visible," attacks Mitry's defense of orthochromatic stock by defending panchromatic film (quoted from Teresa de Lauretis and Stephen Heath, ed. *The Cinematic Apparatus.* New York: St. Martin's, 1980): "A further advantage. . . the replacement of orthochromatic by panchromatic stock depends again on the greater sensitivity of the latter. Not only did the gain in sensitivity permit the realignment of the 'realism' of the cinematic image with that of the photographic image, it also compensated for the loss of light due to the change from a shutter speed of 16 or 18 frames per second to the speed of 24 frames a second necessitated by sound." (131) The only way such compensation could occur is if the *overall* film speed (ASA) of panchromatic film were higher. As Barry Salt points out (p. 222) panchromatic and ortho stock were about the same speed (20–25 ASA), and Kodak introduced a superspeed ortho film (ASA 40–50) in 1926. Thus there was no speed advantage in panchromatic stock. Comolli apparently does not know the difference between red sensitivity and overall film speed. One hopes he has someone else do his light readings and shoot his films.

4. See Heath, *Questions of Cinema,* 226–229.

5. George Lellis, "Perception in the Cinema: a Fourfold Confusion" in *Intermedia,* ed. Gary Gumpert & Robert Cathcart. New York: Oxford, 1979. p. 388.

6. I am indebted to Gorham Kindem's unpublished paper, "Theories of Film Technology: the Case of Color Film," for the insight that Foucault's theories could be applied to specific issues within film's technical history.

7. David Bordwell, *Narration in the Fiction Film.* Madison: University of Wisconsin Press, 1985.

8. I am indebted to James Langwell, Lanco Sound, Inc., Atlanta GA, for theoretical and practical instruction in insert re-recording techniques and for contacts with ADR specialists.

9. See Peter Wollen, "Cinema and Technology: A Historical Overview" in de Lauretis & Heath, eds., *The Cinematic Apparatus,* 14–22. Wollen correctly asserts that the most important breakthroughs throughout film history have been in film stock—in chemistry not mechanics. Information on filmstocks in my essay are from *American Cinematographer, J.S.M.P.T.E.,* and manufacturers' technical representatives.

10. See David W. Leitner, "A Look at Color Negative," *The Independent* Vol. 4, Number 10, February 1982, 5–6 for a description of six-layer negative filmstock technology.

11. Ron Magid, "*Full Metal Jacket:* Cynic's Choice," *American Cinematographer* September 1987, 74–84.

12. See George Turner, "*Out of Africa:* David Watkin," *American Cinematographer* April 1986, 84–86. Watkin used Agfa for exteriors, Kodak for interiors. Watkin claims he liked Agfa's wide latitude and soft colors; one wonders, however, if the reason might have been that with Eastman stock, shooting outside in bright light, black and Caucasian faces are difficult to expose in the same frame; with Agfa or Fuji it's no problem. Eastman's technical representatives admit it's best to use a "Half Double Fog" filter in front of the lens when filming very dark-skinned blacks and light-skinned whites under harsh sunlight. There is a case to be made for issues of skin color being built into even filmstock specifications.

13. Jean-Pierre Grasset of Les Films du Soir first informed me of DeNiro's sub-recordable sound levels; a crewmember on *Angel Heart* confirmed it. In *Once Upon a Time in America,* however, DeNiro's location dialogue was mostly usable, despite its low volume; the soundman mixed inputs from a number of hidden microphones to get usable takes.

14. See Stig Bjorkman, Torsten Manns, & Jonas Sima, *Bergman on Bergman: Interviews with Ingmar Bergman,* trans. Paul Britten Austin. New York: Simon and Schuster, 1973. 257–258. When exactly Bergman began "matching" dialogue in postproduction is